Ordering number: EN3535A

Monolithic Linear IC

LA4581MB

Preamplifier + Power Amplifier for 3V Headphone Stereos

Overview

The LA4581MB is an auto reverse-supported preamplifier + power amplifier IC that is intended for use in 3V headphone stereos.

Features

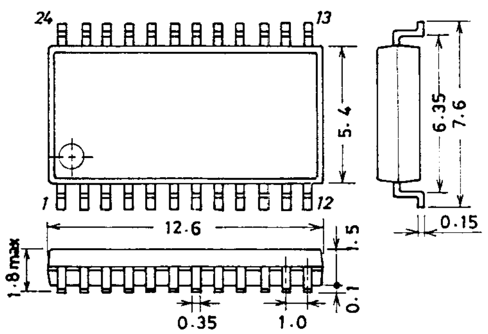
- Preamplifier muting and preamplifier output on/off can be implemented with one pin. This IC can easily be used to construct a set with a radio.
- The power amplifier needs no input/output coupling capacitor.
- A high-frequency cut capacitor is connected to the preamplifier input pin and the power amplifier input pin. (Anti-buzz provision)
- Because V_{ref} AMP (r_0 = 10 Ω) is built in, the virtual grounding impedance is about 10 Ω. This eliminates the need for a large capacitor.
- 8 Ω speaker drivable.

Package Dimensions

unit : mm

3112-MFP24S

[LA4581MB]



SANYO : MFP24S

Specifications

Maximum Ratings at Ta = 25 °C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	V_{CC} max		4.5	V
Allowable power dissipation	Pd max		530	mW
Operating temperature	Topr		–20 to +75	°C
Storage temperature	Tstg		–40 to +125	°C

Operating Conditions at Ta = 25 °C

Parameter	Symbol	Conditions	Ratings	Unit
Recommended supply voltage	V_{CC}		3.0	V
Operating supply voltage range	V_{CC} op		1.8 to 3.6	V

Operating Characteristics at Ta = 25 °C, V_{CC} = 3.0 V, f = 1 kHz, 0.775 V = 0 dBm, R_L = 10 kΩ (preamplifier), R_L = 16 Ω (power amplifier)

Parameter	Symbol	Output	min	typ	max	Unit
[Pre + Power]						
Quiescent current	I_{CCO}	Rg = 2.2 kΩ (preamplifer) V_{IN} = 0 V		17	27	mA
Voltage gain (Closed)	VG_T	V_O = –5 dBm	65	68	71	dB

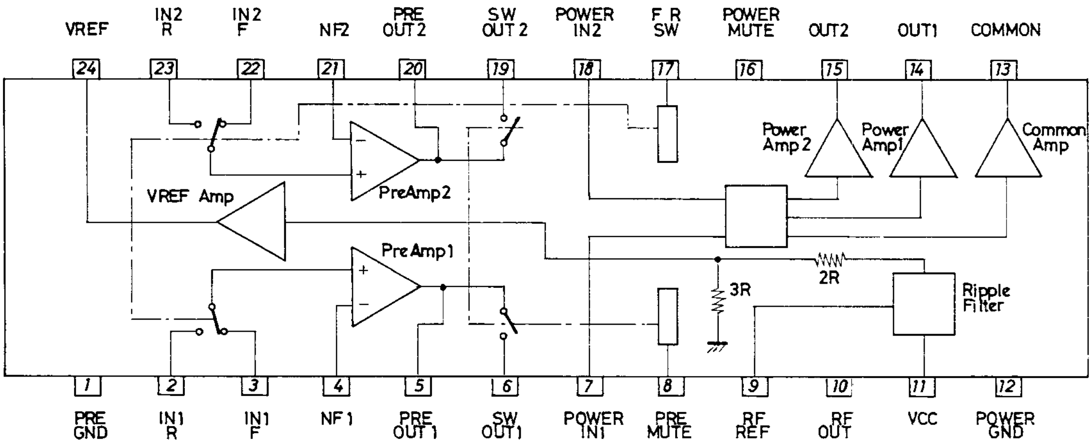
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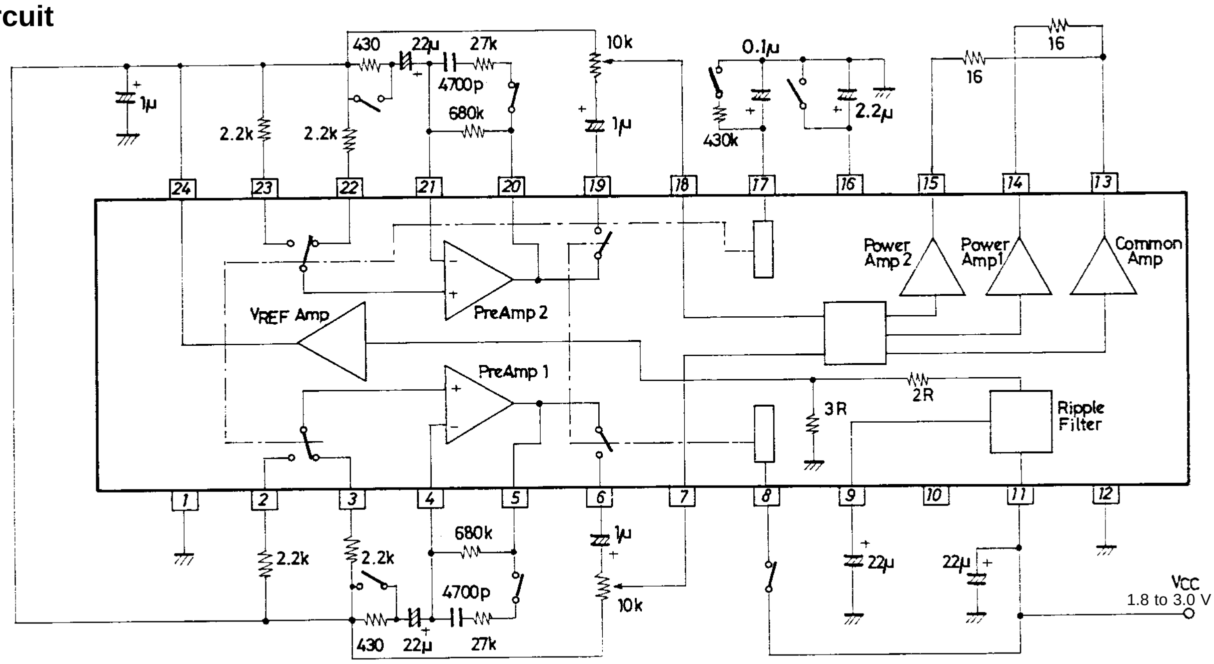
Parameter	Symbol	Output	min	typ	max	Unit
[Preamplifier]						
Voltage gain (Open)	VGo	V_O = –5 dBm	70	80		dB
Voltage gain (Closed)	VG1	V_O = –5 dBm		40		dB
Maximum output voltage	$V_O$max	THD = 1 %, V_{CC} = 1.8 V	0.1	0.2		V
Total harmonic distortion	THD1	V_O = 0.2 V, VG = 40 dB/NAB		0.05	0.5	%
Equivalent input noise voltage	V_N1	Rg = 2.2 kΩ, B.P.F = 20 to 20 kHz		1.3	2.0	µV
Crosstalk	CT1	Rg = 2.2 kΩ, TUNE 1 kHz	60	80		dB
Ripple rejection ratio	R_r1	Rg = 2.2 kΩ, V_{CC} = 1.8 V, Vr = –20 dBm, f = 100 Hz	40	50		dB
[Power Amplifer]						
Output voltage	P_O	THD = 10%	23	32		mW
Voltage gain (Closed)	VG2	V_O = –5 dBm	25	28	31	dB
Total harmonic distortion	THD2	P_O = 1 mW		0.4	1.0	%
Interchannel crosstalk	CT_T	V_O = –5 dBm, R_V = 0 Ω	30	40		dB
Output noise voltage	V_{NO}	Rg = 0, B.P.F = 20 to 20 kHz		24	40	µV
Ripple rejection ratio	R_r2	Rg = 0, V_r = –20 dB, f = 100 Hz, V_{CC} = 1.8 V	45	60		dB
Input resistance	R_{IN}		22	30	38	kΩ
DC offset voltage	V_{ODC}off	Between 13-14 and 15	–90		+90	mV

Note) Power amplifier voltage gain VG2 increases by about 1 dB for min/max respectively than specified above when R_L = 32 Ω.

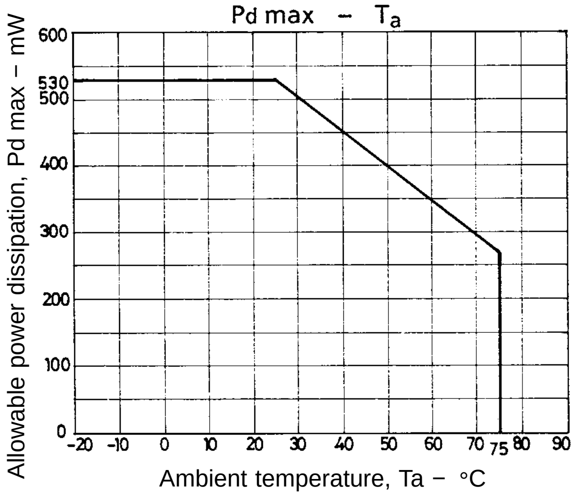
Block Diagram



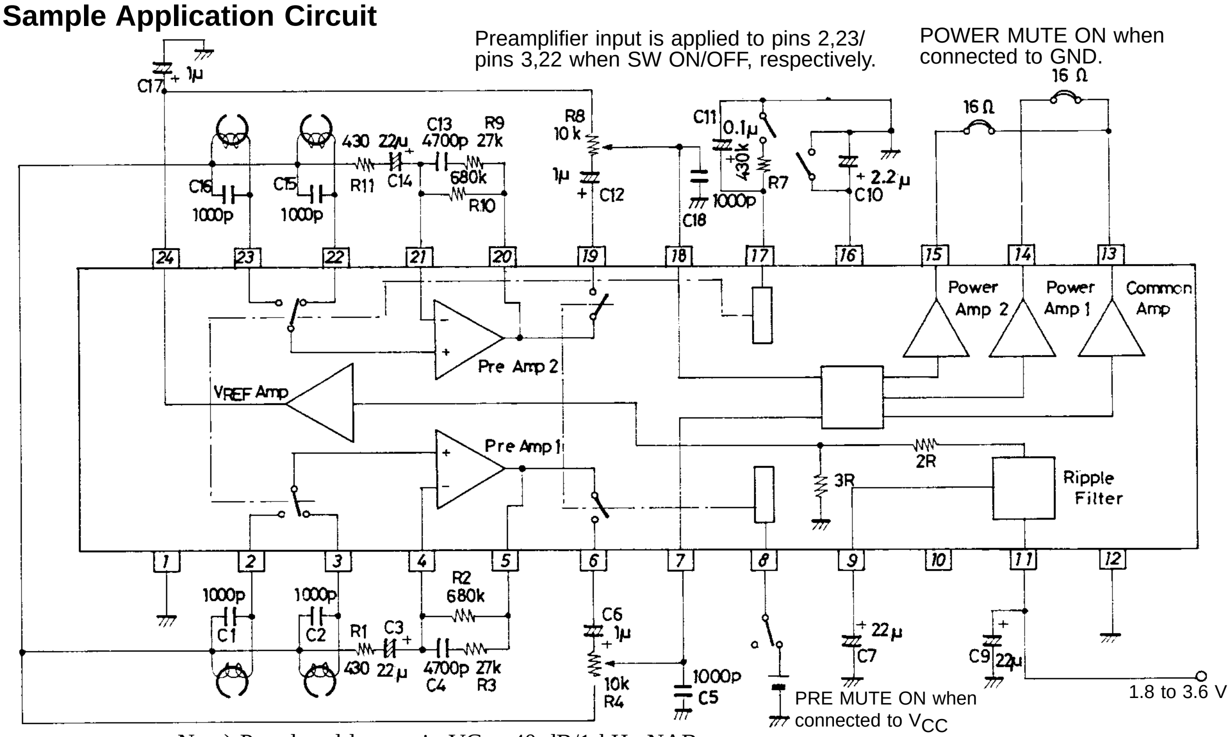
Test Circuit



Unit (resistance: Ω, capacitance: F)



Sample Application Circuit



Note) Pre closed loop gain VG = 40 dB/1 kHz NAB

Unit (resistance: Ω, capacitance: F)

Pin and external part functions (when the voltage is V_{CC} = 3.0 V)

Pin No.	Pin Function
1	PRE GND
2	PRE IN1R 1.8 V • Turns ON when pin 17 is grounded. • A bias resistor (2.2 kΩ) must be connected between pin 2 and pin 24 (V_{ref}) when no head is in use.
3	PRE IN1F 1.8 V • Turns ON when pin 17 is floating. • A bias resistor (2.2 kΩ) must be connected between pin 3 and pin 24 (V_{ref}) when no head is in use.
4	PRE NF1 1.8 V
5	PRE OUT1 1.8 V • Like pin 6, 10 kΩ load drivable.
6	SW OUT1 1.8V • Provides PRE AMP1 output when pin 8 is floating (PRE MUTE OFF)(equivalent to pin 5). • Disconnects from PRE AMP1 and sets R_{IN} ≧ 500 kΩ when pin 8 is at V_{CC} (PRE MUTE ON).
7	POWER IN1 1.8V • Input resistance R_{IN} ≑ 30 kΩ

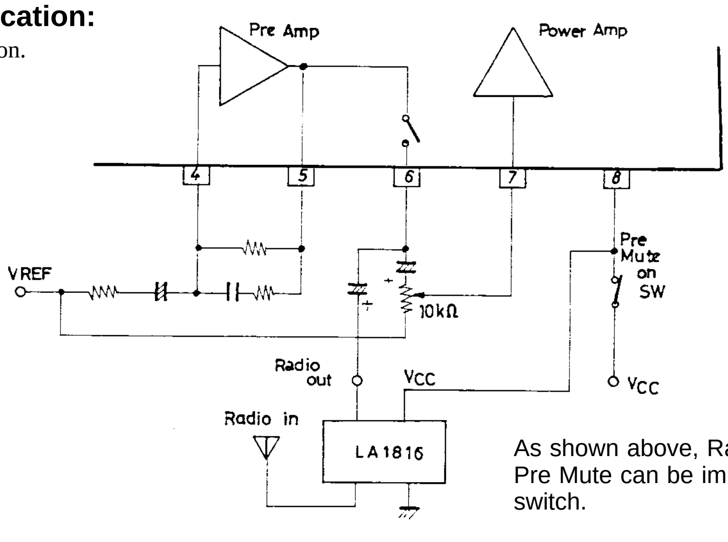
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Pin No.	Pin Function
8	PRE MUTE • When V_{CC} is applied, PRE MUTE ON. • MUTE ON conditions: V_{8IN} ≧ V_{CC} – 0.2 V, inflow current I_7 ≒ 60 µA (when V_{CC} = 3 V)
9	Ripple Filter REF 2.7 V(C_7 = 2.2 µF to 33 µF) • Ripple Filter, V_{ref} reference • The V_{ref} ripple rejection ratio worsens when C_7 is made smaller. • R_r is 55 dB for 22 µF; 35 dB for 2.2 µF.
10	Ripple Filter OUT 2.7 V • Ripple rejection ratio: R_r is 38 dB when C_7 = 22 µF; 30 dB when C_7 = 2.2 µF. • Outflow current I_7 max = 1 mA
11	V_{CC} 3.0 V
12	POWER GND
13	COMMON 1.2 V
14	POWER OUT1 1.2 V • CH1 output.
15	POWER OUT2 1.2 V • CH2 output
16	POWER MUTE 0.7 V (C_{10} = 1.0 µF to 4.7 µF) • When connected to GND: POWER MUTE ON. • MUTE ON conditions: V_{16} ≦ 0.3 V, outflow current I_{16} ≒ 2.5 µA. • C_{10} can be used to control MUTE TIME. • When C_{10} = 2.2 µF, V_{CC} =3.0 V 0.7 sec.
17	FWD/REV SW (C11 ≦ 0.47 µF) • When connected to GND, PRE IN1R (pin 2) and IN2R (pin 23) turn on. • When floating, PRE IN1F (pin 3) and IN2F (pin 22) turn on. • C_{11} and R_7 are intended for smoothing at the time of switching. • REV condition: V_{17} ≦ 0.2 V.
18	POWER IN2 1.8 V • Input resistance R_{IN} ≒ 30 kΩ
19	SW OUT2 1.8 V • Provides PRE AMP2 when pin 8 is floating (PRE MUTE OFF) (equivalent to pin 20). • Disconnects from PRE AMP2 and R_{IN} ≧ 500 kΩ when pin 8 is V_{CC} (PRE MUTE ON).
20	PRE OUT2 1.8 V • Like pin 19, 10 kΩ load drivable.
21	PRE NF2 1.8V
22	PRE IN2F 1.8 V • Turns on when pin 17 is floating. • A bias resistor (2.2 kΩ) must be connected between pin 22 and pin 24 (V_{ref}) when no head is in use.
23	PRE IN2R 1.8 V • Turns on when pin 17 is connected to GND. • A bias resistor (2.2 kΩ) must be connected between pin 23 and pin 24(V_{ref}) when no head is in use.
24	V_{ref} 1.8 V • The reference voltage is set to 3/5 × V_{CC}. Because Vref AMP (r_O ≒ 10 Ω) is built in, C_{17} can be made smaller (1 µF). • Inflow/outflow current I_{24} = ± 500 µA available.

Sample Application:

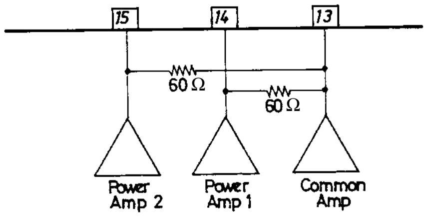
Radio set application.



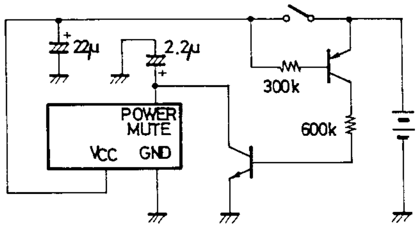
As shown above, Radio on and Pre Mute can be implemented with one-circuit switch.

IC Usage Notes

1. The power amplifier outputs and the common amplifier output are connected through resistors of about 60 Ω. The resistors are for common amplifier oscillation blocking.



2. The preamplifier muting function isolates the preamplifier outputs from SW OUT. The preamplifier is on even when the preamplifier muting is on.
3. If transient noise is noticeable when the power supply is turned off, add the external circuit described below. Transient noise when the power is turned off can be improved by rapidly applying the power amplifier muting.



Unit (resistance: Ω, capacitance: F)

However, the standby current I_{ST} flows even when the power switch is off

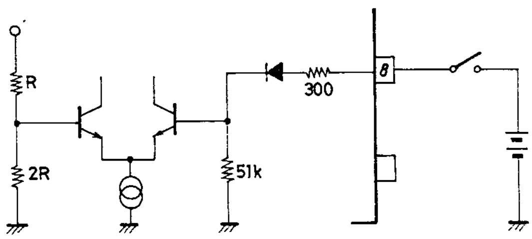
$I_{ST} = (V_{CC} - V_{BE})/600\ k\Omega$

When $V_{CC} = 3.0$ V

$I_{ST} = (3.0 - 0.6)/600\ k\Omega \doteqdot 4\ \mu A$

4. Internal equivalent circuit for each SW pin.

• Pre-mute

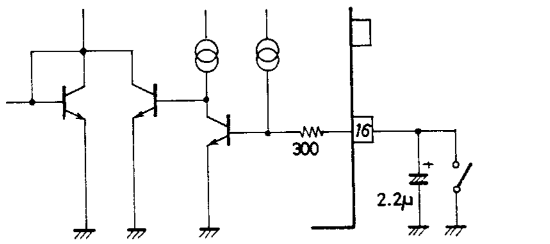


Unit (resistance: Ω)

MUTE ON condition : $V_{8IN} \geqq V_{CC} - 0.2$ V

Inflow current : $I_8 \doteqdot 60\ \mu A$ (when $V_{CC} = 3.0$ V)

• Power mute

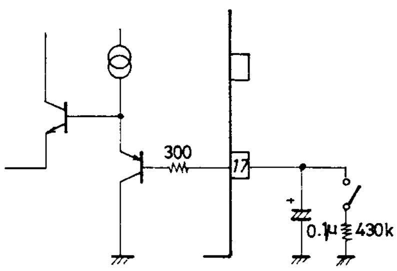


Unit (resistance: Ω, capacitance: F)

MUTE ON condition : $V_{16} \leqq 0.3$ V

Outflow current : $I_{16} \doteqdot 2.5\ \mu A$

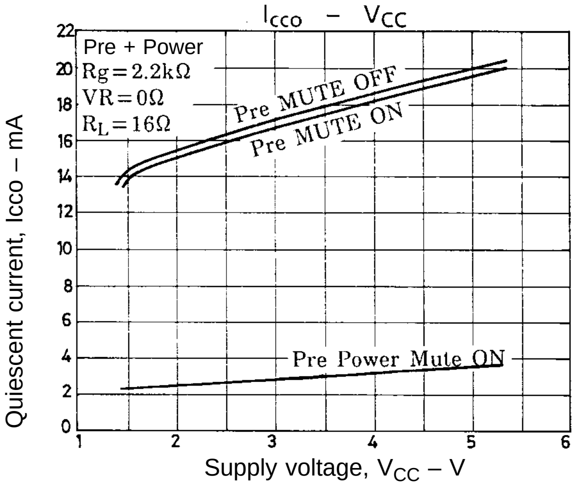
• F/R SW



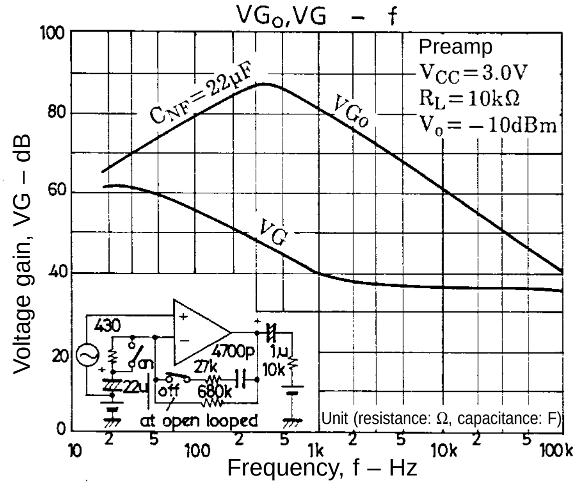
Unit (resistance: Ω, capacitance: F)

REV condition : $V_{17} \leqq 0.2$ V

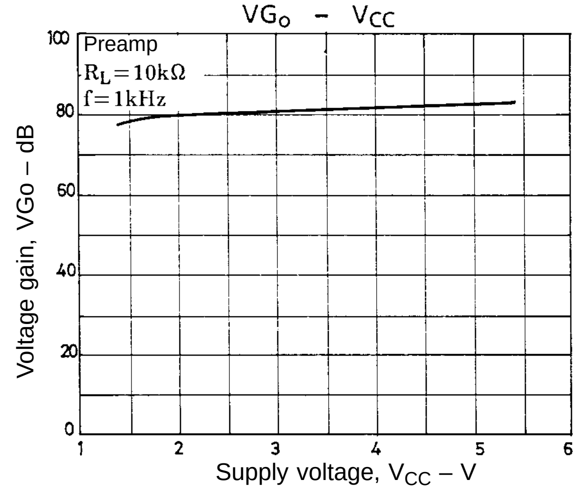
I_{cco} – V_{CC}



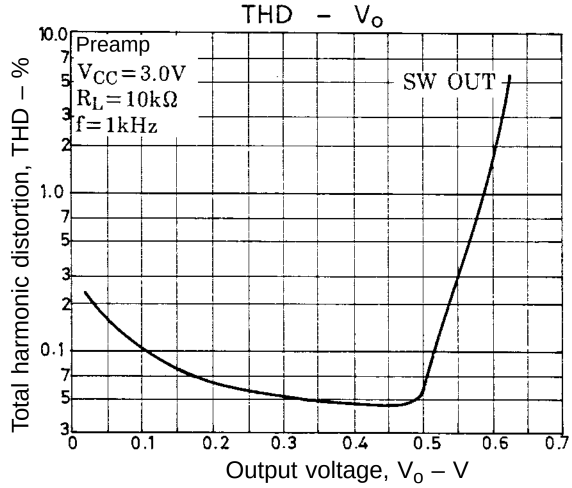
VG_o, VG – f



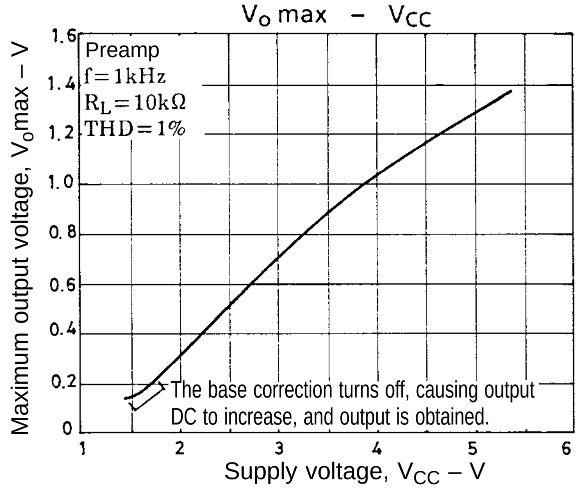
VG_o – V_{CC}



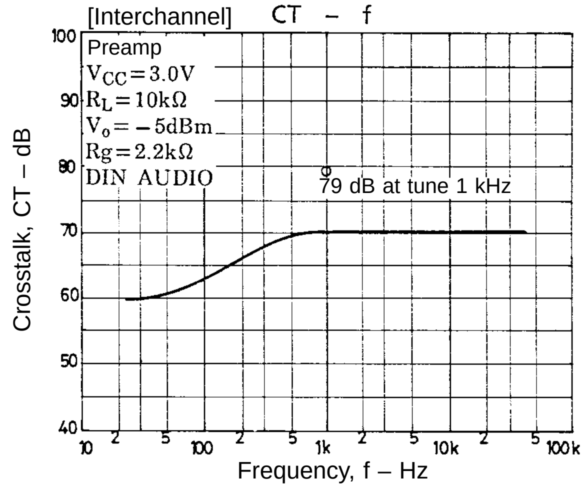
THD – V_o



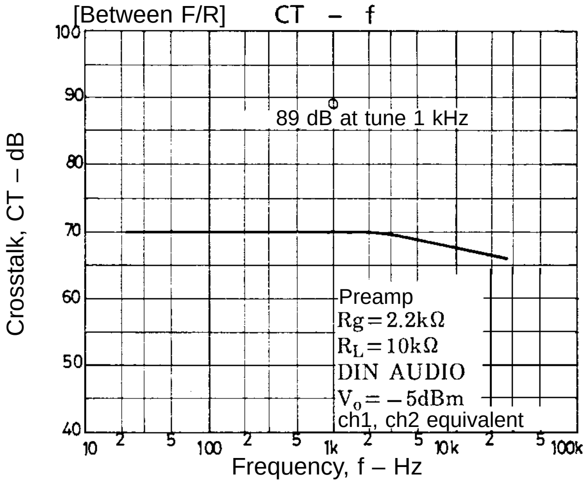
V_o max – V_{CC}



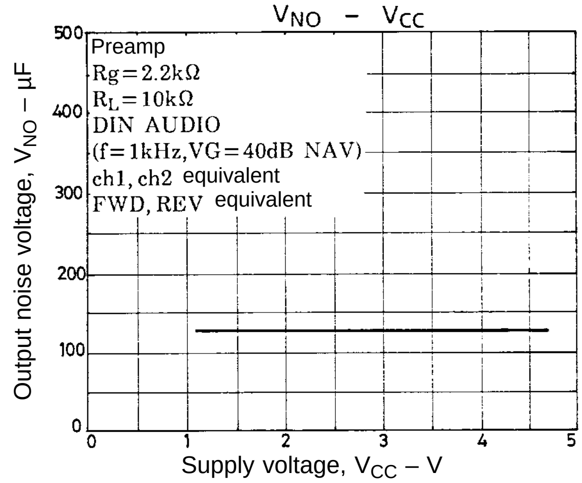
[Interchannel] CT – f

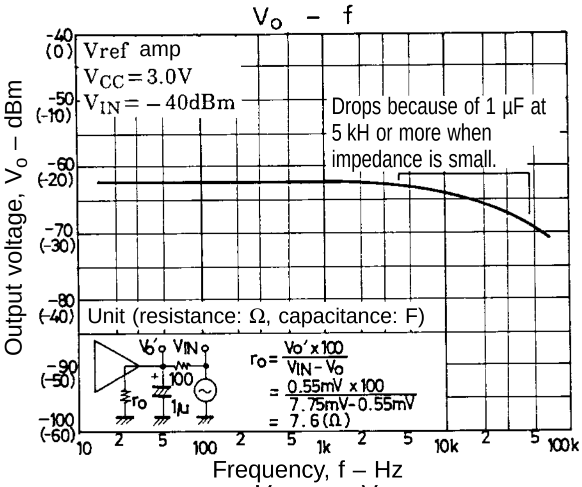


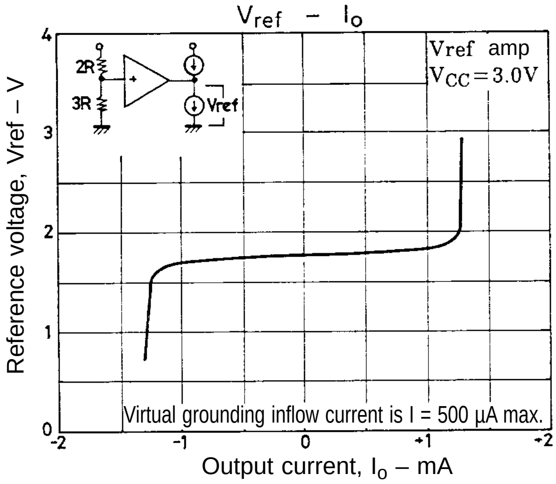
[Between F/R] CT – f

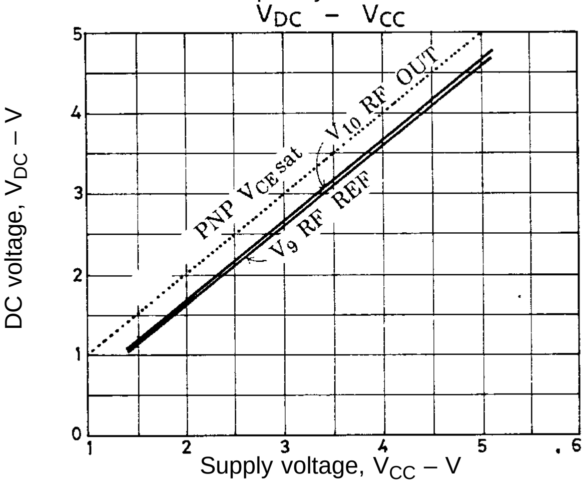


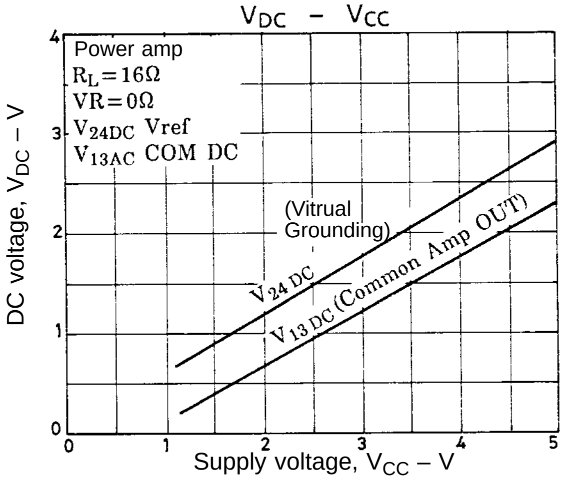
V_{NO} – V_{CC}

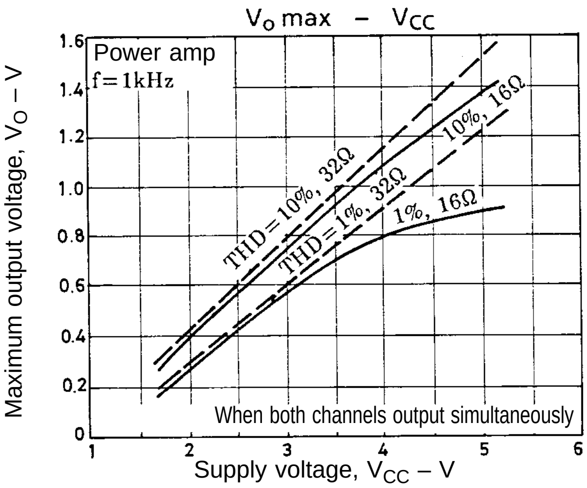


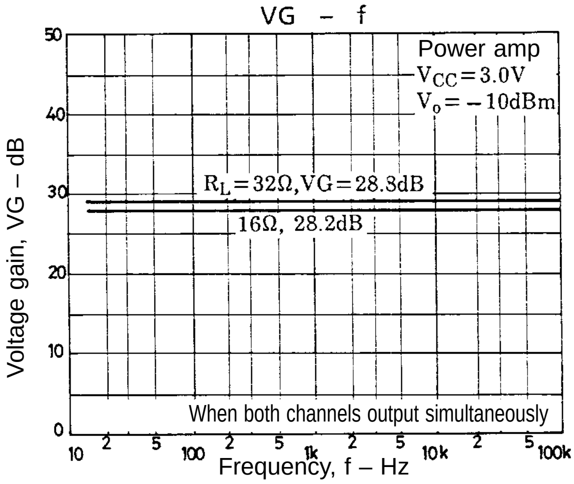

Vo – f
Vref amp
VCC=3.0V
VIN=–40dBm
Drops because of 1 µF at 5 kH or more when impedance is small.
Unit (resistance: Ω, capacitance: F)
ro = Vo' x 100 / (VIN – Vo) = 0.55mV x 100 / (7.75mV – 0.55mV) = 7.6 (Ω)
Output voltage, Vo – dBm
Frequency, f – Hz

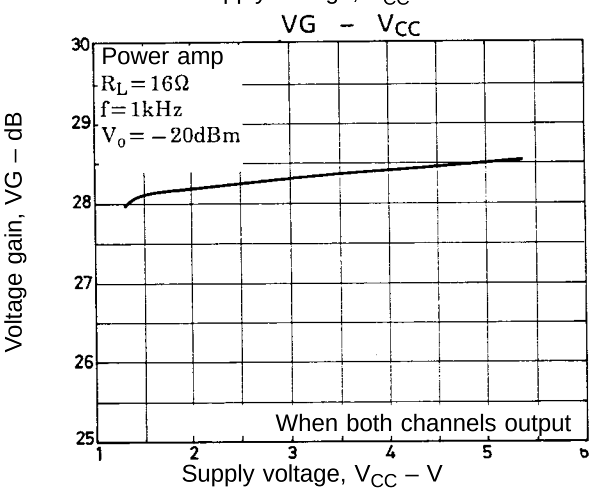

Vref – Io
Vref amp
VCC=3.0V
Virtual grounding inflow current is I = 500 µA max.
Reference voltage, Vref – V
Output current, Io – mA

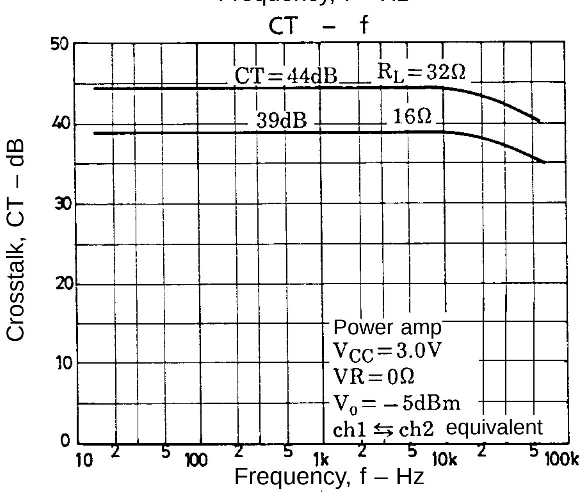

VDC – VCC
PNP VCE sat
V10 RF OUT
V9 RF REF
DC voltage, VDC – V
Supply voltage, VCC – V

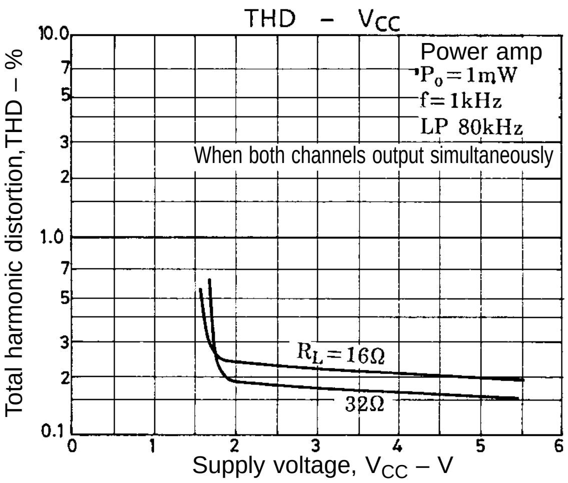

VDC – VCC
Power amp
RL=16Ω
VR=0Ω
V24DC Vref
V13AC COM DC
(Vitrual Grounding)
V24 DC
V13 DC (Common Amp OUT)
DC voltage, VDC – V
Supply voltage, VCC – V

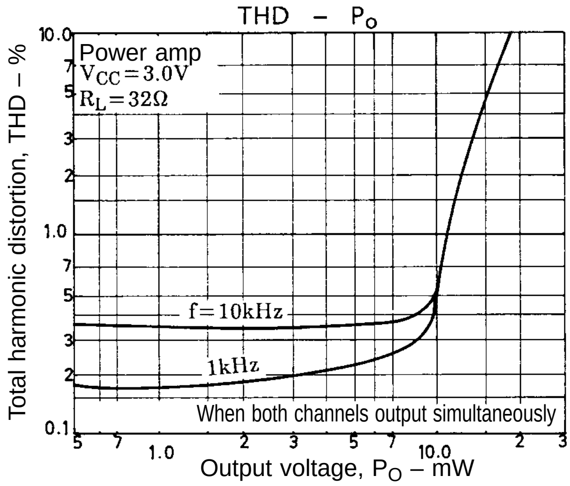

Vo max – VCC
Power amp
f=1kHz
THD=10%, 32Ω
10%, 16Ω
THD=1%, 32Ω
1%, 16Ω
When both channels output simultaneously
Maximum output voltage, VO – V
Supply voltage, VCC – V

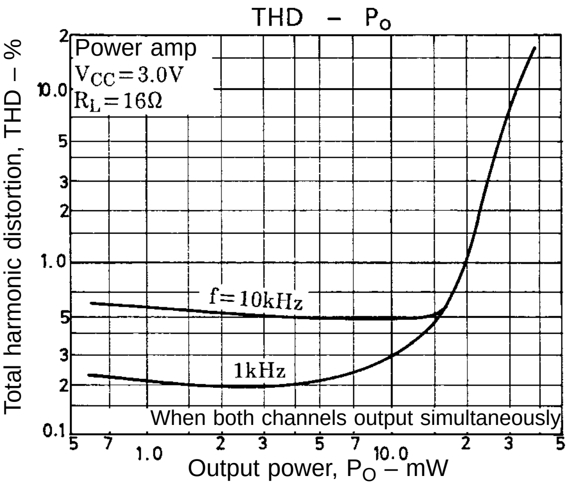

VG – f
Power amp
VCC=3.0V
Vo=–10dBm
RL=32Ω, VG=28.3dB
16Ω, 28.2dB
When both channels output simultaneously
Voltage gain, VG – dB
Frequency, f – Hz

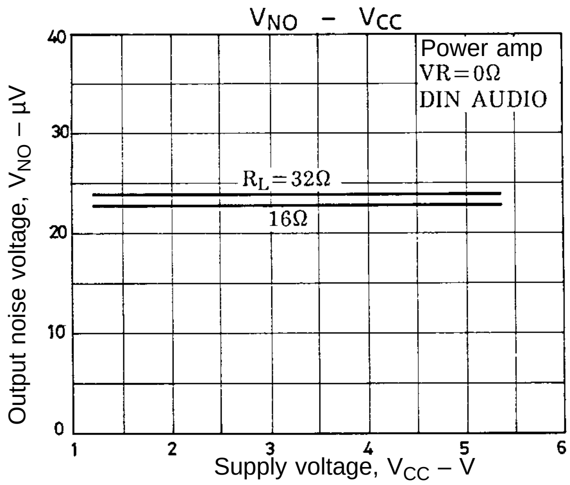

VG – VCC
Power amp
RL=16Ω
f=1kHz
Vo=–20dBm
When both channels output
Voltage gain, VG – dB
Supply voltage, VCC – V

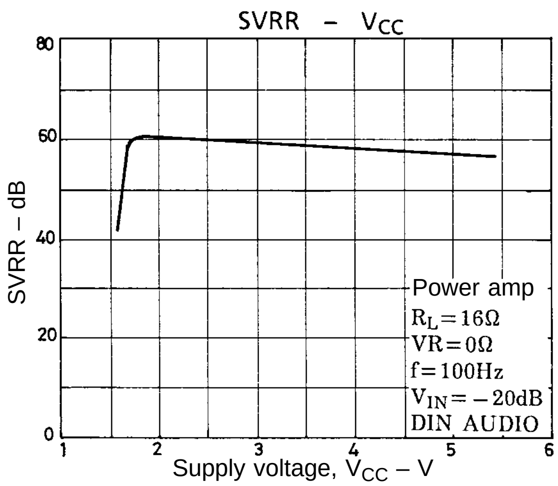

CT – f
CT=44dB
RL=32Ω
39dB
16Ω
Power amp
VCC=3.0V
VR=0Ω
Vo=–5dBm
ch1 ⇆ ch2 equivalent
Crosstalk, CT – dB
Frequency, f – Hz

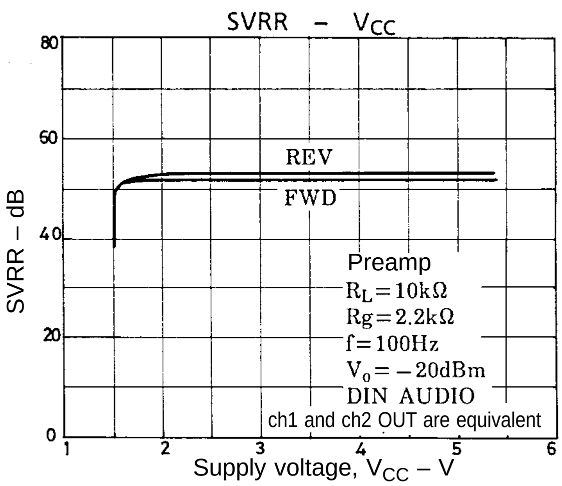

THD – VCC
Power amp
Po=1mW
f=1kHz
LP 80kHz
When both channels output simultaneously
RL=16Ω
32Ω
Total harmonic distortion, THD – %
Supply voltage, VCC – V


THD – Po
Power amp
VCC=3.0V
RL=32Ω
f=10kHz
1kHz
When both channels output simultaneously
Total harmonic distortion, THD – %
Output voltage, PO – mW


THD – Po
Power amp
VCC=3.0V
RL=16Ω
f=10kHz
1kHz
When both channels output simultaneously
Total harmonic distortion, THD – %
Output power, PO – mW


VNO – VCC
Power amp
VR=0Ω
DIN AUDIO
RL=32Ω
16Ω
Output noise voltage, VNO – µV
Supply voltage, VCC – V


SVRR – VCC
Power amp
RL=16Ω
VR=0Ω
f=100Hz
VIN=–20dB
DIN AUDIO
SVRR – dB
Supply voltage, VCC – V


SVRR – VCC
REV
FWD
Preamp
RL=10kΩ
Rg=2.2kΩ
f=100Hz
Vo=–20dBm
DIN AUDIO
ch1 and ch2 OUT are equivalent
SVRR – dB
Supply voltage, VCC – V